

Full Length Research Paper

Ecological baseline survey of the Takoradi T2 expansion and a once-through cooling system project site, Aboadze, Ghana

Gad Y. Coffie^{1*}, Afia Y. Bediako² and Paula E. Edze³

¹Forestry Commission, Bia Conservation Area, P O Box 171, Sefwi-Wiawso, Ghana.

²Faculty of Biosciences, KNUST, Kumasi, Ghana.

³Energy Commission, Accra, Ghana.

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The Environmental Assessment Regulations (LI 1652) of Ghana mandates all bodies undertaking activities that may significantly impact the environment to conduct Environmental Impact Assessment. It is in accordance with this legal provision that an Ecological Baseline Survey was conducted at the Takoradi Thermal Power Plant (TTPP) site located 2 km East of Aboadze near Takoradi to determine the existing flora and fauna and the potential impacts of the T2 Expansion Project on them. Data on the flora and fauna of the project site was gathered through primary and secondary sources such as desk study of previous reports, field survey, focus group discussions and a town-hall meeting. It was discovered that the coastal ecosystem of the project area was fairly pristine except for routine grazing and anthropogenic activities. Biodata collected indicated the predominance of invertebrates, coconut palms, sisals and grasses; while reptiles and small mammals (rodents) were also observed. No turtle nesting sites were observed. Potential impacts of the project include: displacement of aquatic flora and fauna, contamination of marine and terrestrial ecosystems and distortion of food webs. Despite the foregoing, the socioeconomic significance of the T2 expansion project to Ghana is crucial and is worth the ecological trade-off. It was recommended among others for ornamental plants to be planted along the streets of the plant upon completion of the project.

Key words: Thermal energy, once-through cooling system, littoral area, ecological baseline survey, offshore.

INTRODUCTION

The Government of Ghana has since 1965 being providing electricity for the much needed development of the country (Barry et al., 2005). The Volta River Authority (VRA) which was incorporated since then to manage

electricity generation and distribution has diversified the source of power generation from the conventional hydro-electricity concept to other sources such as Thermal Power Generation (TPG) and solar power generation.

*Corresponding author. E-mail: gadcoffie@gmail.com.

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The VRA has over the years, with strategic investors, begat other companies that have taken up the challenge to increase the installed capacity of Ghana's power needs (Volta River Authority, 2014).

Like all human endeavours, TPG has associated ecological influence which, since mostly can be detrimental to living organisms, must be duly managed in the most sustainably expedient manner possible.

Thermal power production began in Ghana in April 1999 at Aboadze in the Western Region of Ghana. Since the commissioning of the first Takoradi Thermal Plant known as T1, other expansion has taken place. Though meant to be an add-on, TPG has become almost a substitute to hydro-electric power. Hydro Electric Power (HEP) is cheaper but due to erratic weather ostensibly attributable to climate change; TPG had to be resorted to irrespective of the high cost. In the past couple of decades, it is clear TPG is a remedy to the hiking energy demands of modern Ghanaian society vis-a-vis the deteriorating energy situation in the country (Anonymous, 2013).

Takoradi Thermal Power Plant (TTPP) is an independent power producer jointly owned by VRA and TAQA Energy of Abu Dhabi (Anonymous, 2013). For the purposes of the development, Takoradi International Company (TICO) was incorporated. Each of the thermal plants was identified by Takoradi plus a natural number such as Takoradi 1, Takoradi 2 or T1, T2 etc. (World Bank Group, 2015).

Because of the long timeframe over which the various stages of T2 development have taken place, the 1999 Construction Permit lapsed before the construction of the final combined-cycle stage of T2. TICO therefore proposed to construct the final combined-cycle stage of T2 (known as "T2 expansion"), as well as a 'once-through' cooling water system to serve T1 and T2 and improve plant efficiency. The T2 expansion is to result in an installed capacity of 120MWe (Anonymous, 2013, Volta River Authority, 2014).

A key feature of the T2 expansion is a seawater desalination plant (water to be sourced about 1 km offshore). In addition, a once-through cooling water system (structure located 2.5 km offshore) supports operations at both T1 and T2, thereby removing reliance of T2 on freshwater. This final phase of T2 is expected to increase the generating capacity of the facility by 50 percent without additional fuel requirements and without increasing greenhouse gas emissions (World Bank Group, 2015).

The original combined cycle combustion turbine unit, T1 has been in full, 330 MWe, combined-cycle operation since 1999. The T1 steam turbine uses a cooling tower system, fed with seawater to cool the steam turbine condenser. T2 expansion shall lead to additional energy production without additional fuel use or extra atmospheric emissions. A 'once-through' cooling system to be

constructed is expected to significantly reduce noise emissions as the existing cooling towers would no longer be necessary (Anonymous, 2013).

The coastal zone of Ghana covers about 6.5% of the total area and of the ten political regions; four have coast lines, Greater Accra, Volta, Central and Western. According to the Ghana National MAB Committee (2009), Ghana's coastline stretches over a distance of 550km and is drained by four major rivers.

The Environmental Assessment Regulations 1999, Legislative Instrument (LI) 1652 mandates all bodies undertaking activities that may significantly impact the environment to conduct Environmental Impact Assessment (EIA) of the project. As part of the conduct of such an assessment, an ecological baseline audit is needed to establish the true ecological status quo before any project begins.

The TTPP is a very economically crucial project for the ultimate industrialisation of Ghana. To that extent therefore, the rationale of this survey was to establish an ecological baseline data which shall be used but not limited to; determining the environmental opportunity cost of the TTPP; projecting, recommending and monitoring the environmental bio-stats of the project site; stating and monitoring possible mitigation measures for the ecological sustainability of the ecosystem; recommending possible medium to long term after-construction surveys, and establishing sanctuaries for *ex-situ* breeding of critically affected (macro) fauna, if any. These objectives are in conformity with the Ramsar Convention on wetlands of which Ghana is a signatory. At the heart of the Ramsar Convention is the 'wise-use' concept of habitat conservation. The most salient consideration here is implementation of ecosystem approaches within the context of sustainable development (Barry et al., 2005; Gleick, 1996).

MATERIALS AND METHODS

Study site

The study was conducted precisely at the TTPP site located 2km East of Aboadze, a small fishing community located on the Southwest coast of Ghana about 15 km from the Western city of Takoradi. The site occurs over an approximate area of 135 000 square metres on shore while the off shore project area spans 56 000 square metres. The soil is mainly sandy with maximum elevation of about 280 m above sea level (Garmin, GPSMAP 62).

Collection of samples

Desk study of a dossier of previous reports on TTPP such as the Environmental and Social Management Plan (ESMP), Construction Environmental Management Plan (CEMP), Consultation Summary Report (CSR) and other project documents were studied by the team. Flora (plant) and fauna (animal) specimen were sampled from the project site to ascertain their

Table 1. List of Flora identified at the T2 expansion site.

Family	Local name	Scientific name
Poaceae	Love grass	<i>Eragrostis species</i>
Poaceae	Elephant grass	<i>Pennisetum purpureum</i>
Poaceae	Guinea grass	<i>Panicum maximum</i>
Arecaceae	Coconut palm	<i>Cocos nucifera</i>
Arecaceae	Date palm	<i>Phoenix dactylifera</i>
Asteraceae	Chromolaena (Acheampong)	<i>Chromolaena odorata</i>
Apocynaceae	Periwinkle	<i>Catharanthus roseus</i>
Fabaceae	Mimosa	<i>Mimosa pudica</i>
Asparagaceae	Sisal	<i>Agave americana</i>
Goodeniaceae	Native Ink-berry	<i>Scaevola species</i>

environmental and economic importance while their earthnobotany was recorded.

A recognisance survey was conducted on the project site in December, 2012, a week to the commissioning of the T2 expansion project. A further survey took place three months later. The project site was inspected by the research team in the company of a Health, Safety and Environment (HSE) staff from Korea Electric Power Corporation Engineering and Construction Company (KEPCO E & C). Fifty randomly positioned North-South transects were surveyed and flora and fauna specimen were observed and identified. Six 2x2 m quadrats, randomly sited not more than 20 m from the morning tide limit of the shoreline, were analysed.

Two focus group discussions were held. Also, about sixty (60) individuals were randomly sampled and interviewed using a short closed-ended questionnaire. Some of the questions asked include; which animal species were prevalent in Aboadze area? Which plant species were prevalent in Aboadze area? Do you think the TTPP will adversely affect your livelihood? Have you ever seen turtles around the TTPP site? And when was the last time you saw a turtle around?

Prediction methodology

Environmental and ecological impacts of the project were predicted based on the following parameters stated by Institute of Ecological and Environmental Management (IEEM); Positive or negative (is the impact likely to be positive or negative?), Magnitude ('size' or 'amount' of an impact, determined on a quantitative basis if possible), extent (the area over which the impact occurs), duration (time the impact is expected to last prior to recovery or replacement of the resource or feature, example species lifecycles), reversibility (is the impact permanent or temporary/ is there a possibility for effective mitigation?), frequency (rate of occurrence of the project activity and hence the resulting impact).

RESULTS

The coastal flora except for routine grazing and anthropogenic activities such as collection of stakes, was quite pristine. The main vegetation of the site comprised of coconut palms, sisals and grasses (predominantly Guinea grass, *Panicum maximum*). A list

of identified flora is represented in Table 1.

Respondents to questionnaires administered mainly indicated that livestock frequently graze around the main project site. A few small scale farms were also present at the project site. Respondents indicated the abundance of a number of un-named migratory birds and cattle egrets (*Bubulcus ibis*). A list of identified fauna is represented in Table 2. Although very few were actually sighted, biodata points to the predominance of invertebrates. Snakes, Agama lizards and small mammals (rodents) were also observed.

Significantly, no turtle nesting sites were observed in the quadrats sampled. The respondents failed to provide concrete evidence to their activities but said they know 'they were there'. The local folks did indicate that their fish stocks have experienced a steady decline though no reasons were assigned.

DISCUSSION

The coastal ecosystem is functionally a very dynamic one. A lot of niches, species and complex nexuses characterise the marine-terrestrial ecosystem. The sea near the Aboadze area, save for fishing, was pretty undisturbed in the days preceding thermal power generation in Ghana. The construction of the dam at Akosombo over the Volta River for hydro electric power generation similarly influenced the ecology of that area (Barry et al., 2005; Opoku-Agyeman, 2001).

The activities of the TTPP were somewhat deleterious ecologically though no detailed scientific survey has as yet confirmed that. The dredging of the sea bed, construction of a breakwater system and bund wall, causing displacement of aquatic fauna, plankton and algae, heaping of earth to heights in the excess of 4 metres that apart from burying certain invertebrates also can impede the normal daily manoeuvres of most reptiles and rodents, noise generated by construction activities, 'unnatural' and persistent light at night at ecologically

Table 2. List of Fauna identified at the T2 expansion site.

Family	Local name	Scientific name(S)
Cheloniidae	Leatherback turtle	<i>Dermochelys coriacea</i>
Cheloniidae	Green turtle	<i>Chelonian mydas</i>
Agamidae	Agama lizard	<i>Agama agama</i>
Nesomyidae	Giant rat	<i>Cricetomys gambianus</i>
Thryonomyidae	Cane rat	<i>Thryonomys swinderianus</i>
Bovidae	Goat	<i>Capra aegagrus hircus</i>
Bovidae	Sheep	<i>Ovis aries</i>
Ardeidae	Cattle egret	<i>Bubulcus ibis</i>
Ardeidae	Great white egret	<i>Egretta alba</i>
Elapidae	Spitting Cobra	<i>Naja nigricollis</i>
Cichlidae		<i>Sarotherodon melanotheron</i>
Cichlidae	Tilapia	<i>Tilapia</i> spp
Cichlidae		<i>Hemichromis</i> spp
Claridae		<i>Claridae</i> spp
Portunidae	Crab	<i>Callinectes amnicola</i>

detrimental levels, ecologically wanton excavation leading to mass annihilation of flora, fauna and potential contamination (noticeable by ocular observation) of the sea water and its biochemical effects on fish, algae and littoral marine flora were the most serious effects the earlier phases of the TTPP had on the Aboadze shoreline.

Predicted composite potential impacts of the expansion project on the marine ecosystems included; displacement of some aquatic flora and fauna, contamination of marine ecosystem and distortion to the aquatic food web. For the terrestrial ecosystem, there shall potentially be: migration of some terrestrial fauna, land pollution, distortion to the terrestrial food web and improvement in the socioeconomic life of fringe communities. Unlike in the case of the Akosombo dam where about 80 000 people were displaced (Barry et al., 2005); the TTPP shall not cause any displacement or evacuation of human beings.

In mitigating the negative effects of the expansion project on the Aboadze area ecosystem, better geological best practices must be employed in the dredging of the sea bed off shore to minimise destruction to marine life, coconut palms, other palms, lawns and other plants identified on site should be planted when the project is about 70% completed to encourage the continual visitation of cattle egrets and other fauna to the site even after construction.

Conclusion

Although no population estimates were made, biodata reviewed significantly pointed at a 'fairly stable' ecosystem of very viable populations. The Aboadze area

ecosystem shall suffer some loses such as pollution, distortion to the food web of the project site especially at the two most basic trophic levels, but if the recommended mitigation measures are implemented, monitored, and reviewed where necessary, the extent of disturbance shall be weathered over a period.

The Aboadze Area ecosystem cannot be compromised irretrievably in the name of TPG. However, the socioeconomic significance of the TTPP to Ghana is very crucial and therefore worth the afore-described trade-off.

Conflict of Interest

The authors do not declare any conflict of interest.

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